

Department of Civil and Geological Engineering  
GEO E 475.3: Advanced Hydrogeology  
MIDTERM EXAMINATION

Time Allowed: 1 hour

27 October 2006

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SECTION A

(Multiple-choice 3 marks each - spend up to 10 minutes - PLEASE USE ANSWER BOOK)

1. In the hydrologic cycle, which of the following approximate balances is closest to being true?  
  - a. precipitation = evaporation - runoff
  - b. precipitation = runoff - evaporation
  - c. precipitation = evaporation + runoff
  - d. precipitation = evaporation x runoff
  - e. precipitation = evaporation / runoff
2. Which of these statements about human activities and the hydrologic cycle is false?  
  - a. Building roads and parking lots increases the amount of infiltration.
  - b. Use of irrigation waters in dry areas increases the amount of evaporation.
  - c. Human contributions to global and local warming can change the balance of water in different hydrologic reservoirs.
  - d. Runoff patterns are altered when water is diverted from one region to another.
  - e. Uranium mineralization is controlled by the movement of groundwater.
3. Which of the following statements about the water table is true?  
  - a. The water table changes when discharge is balanced by recharge.
  - b. The water table has the same general shape as the topography.
  - c. The water table is deep below the land surface beneath lakes.
  - d. The water table is elevated near high volume pumping wells.
  - e. The water table fluctuates with changes in atmospheric pressure.
4. Darcy's Law states that the volume of water flowing through a unit cross-sectional area per unit time is equal to \_\_\_\_\_.  
  - a. porosity x hydraulic conductivity
  - b. porosity x hydraulic gradient
  - c. hydraulic conductivity x hydraulic gradient
  - d. hydraulic conductivity x hydraulic gradient x porosity
  - e. hydraulic conductivity x hydraulic gradient / porosity

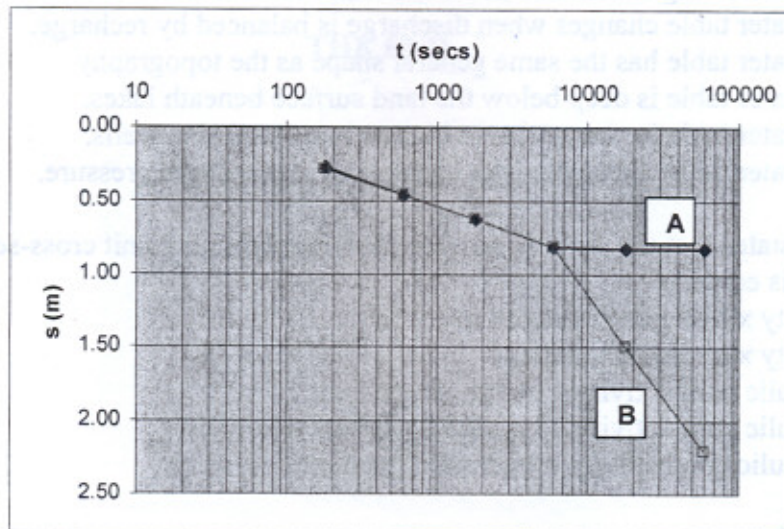
$$Q = K_i A$$
$$\frac{Q}{A} = \frac{K_i}{L} \Delta h$$

5. What is the difference between the saturated and unsaturated zone?
- The saturated zone has a higher porosity than the unsaturated zone.
  - The saturated zone has a lower porosity than the unsaturated zone.
  - The pore spaces in the saturated zone are completely full of water; the pore spaces in the unsaturated zone are not completely full of water.
  - The pore spaces in the saturated zone are not completely full of water; the pore spaces in the unsaturated zone are completely full of water.
  - The saturated zone has a higher permeability than the unsaturated zone.

### SECTION B

(Short answers 5 marks each - spend up to 15 minutes)

- What is the difference between hydraulic conductivity and intrinsic permeability?
- Explain the difference between the release of water from storage in a confined and unconfined (water-table) aquifer?
- What features distinguish a recharge slough from a discharge slough?
- Why might seismicity be increased by the filling of a large surface water impoundment?
- The graphs represent the response of two aquifers (A and B) to pumping at a constant rate.

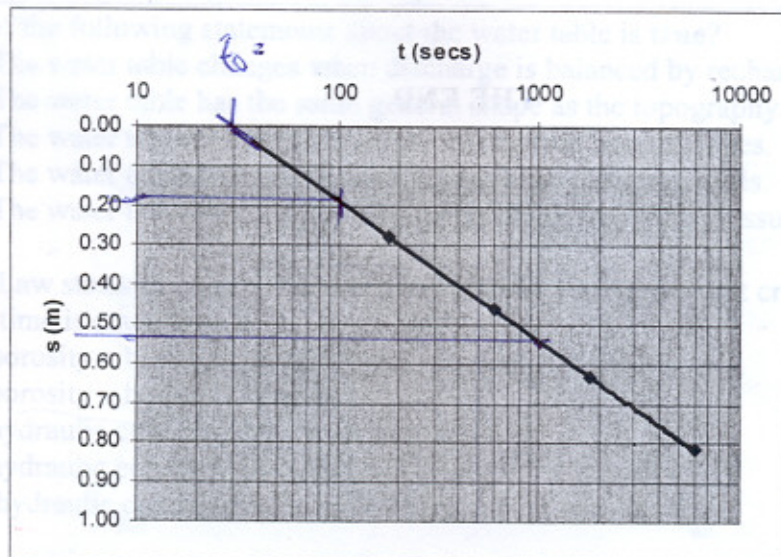


What kinds of boundary condition are indicated by the response of the two aquifers?

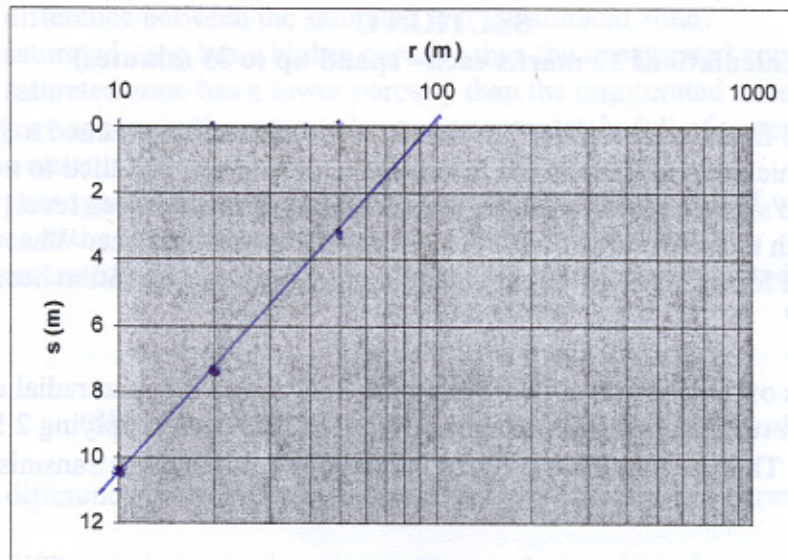


**SECTION C**  
**(Calculations 10 marks each - spend up to 35 minutes)**

- ✓ 11. An unconfined fresh water aquifer [the density of water can be assumed to be  $1,000 \text{ kg/m}^3$ ] has a thickness of 23 m at the location of a piezometer installed to a total depth of 16 m. The land surface elevation at the piezometer is 98 m above sea level, and the measured depth to the water table is 6.5 m below the ground surface. What is the total hydraulic head for the aquifer? What is the pressure head and elevation head at the base of the aquifer?
- ✓ 12. Measurements of drawdowns at two wells were 2.27 m and 0.8 m at radial distances of 10 and 1000 m respectively from a pumped well that has been supplying 2 L/s for several years. Use the Thiem equation [ $s = (Q/2\pi T)\ln(r/R)$ ] to estimate the transmissivity of the aquifer.
- ✓ 13. A circular section of tunnel radius 3.0 m with a length of 200 m allows water to freely flow into the Partagas Pond Protoactinium Mine. Assuming a unit hydraulic gradient and a reasonable value for hydraulic conductivity, estimate the inflow from the sandstone bedrock.
14. The graph shows the  $\ln(\text{time})$  vs drawdown response for an aquifer pumped at a rate of 1.16 L/s. Use the Cooper-Jacob equation [ $s = (Q/4\pi T)\ln(2.25Tt/r^2S)$ ] to estimate the aquifer transmissivity (T) and storage coefficient (S). Is the aquifer confined or unconfined?  $r = 20 \text{ m}$



15. After a well has been pumping for 60 days at a constant rate, three observation wells at radial distances of 10, 20 and 50 m show relatively constant drawdowns of 10.52, 7.51 and 3.53 m respectively. Estimate the radius of influence of the pumped well. Do you think the aquifer confined or unconfined? Justify your answer?



16. Complete the following table in your answer book **using an appropriate number of significant digits**:

	Hydraulic Conductivity (m/s)	Porosity (%)	Specific Yield (%)
Sand			
Silt			
Clay			
Granite			

THE END